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⑥ SATELLITE INFRARED (SIRE) SENSOR DATA PROCESSING
PERSPECTIVE AND DEFINITION - VOLUME III.

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APPENDIX B. COMMENTS ON THE SIRE GROUND SEGMENT SPECIFICATION.

APPENDIX C. COMMENTS ON THE HUGHES SIRE GROUND SEGMENT
CONCEPT AND SYSTEM DESCRIPTION DOCUMENT.

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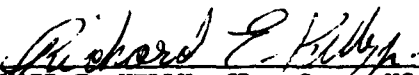
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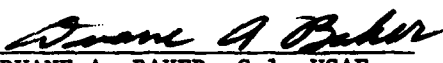
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This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.


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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) As a consequence of its extensive background in infrared technology and data processing of experimental measurements, Riverside Re- search Institute was selected by the Air Force's Space and Missile Systems Organization to provide a data processing perspective to the development of the Satellite Infrared (SIRE) Sensor, and es- tablish requirements for the SIRE data processing and the system and operations for that processing. <i>✓</i>		

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Blk. 20: While this activity has continued uninterrupted since 1976, the emphasis of this report is in the review of RRI's activities from April through September 1978; an interim report of RRI's work from December 1976 through March 1978 has already been issued. The topics covered in this report can be divided into four principal areas: (1) data processing perspective to the SIRE payload, (2) SIRE data processing requirements, (3) definition of the SIRE coordinator, and (4) survey of applicable commercial and DOD data reduction techniques to SIRE.

↙ In this volume, the appendices document the detailed comments resulting from RRI's review of Hughes Aircraft Company's 'SIRE Ground Segment Specifications' and 'SIRE Ground Segment Concept and System Description' documents. ↗

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AUTHORIZATION


This report describes research performed at Riverside Research Institute and was prepared by Thomas Ciccarelli and Ronald Cestaro.

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TABLE OF CONTENTS

	<u>Page</u>
APPENDIX B. COMMENTS ON THE SIRE GROUND SEGMENT SPECIFICATION	1
APPENDIX C. COMMENTS ON THE HUGHES SIRE GROUND SEGMENT CONCEPT AND SYSTEM DESCRIPTION DOCUMENT	7
GLOSSARY	13

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B. COMMENTS ON THE SIRE GROUND SEGMENT SPECIFICATION

This appendix presents the detailed comments resulting from RRI's review of the HAC "SIRE GROUND SEGMENT SPECIFICATION*;" item numbers (page, section, figure, etc.) refer to numbering in that document.

Item: Page 3, Section 3.1.1.1, GS Subsystems. The Quality Evaluation Subsystem (QES) subsumes all the original functions of what was formally called Data Reduction Subsystem.

Item: Page 4, Section 3.1.1.1, GS Subsystems, Part c, Data Analysis Subsystem (DAS). The extraction and processing of target data from background is performed in the DAS only. These functions would have to be incorporated in the QES for a "Phase I" system.

Item: Page 4, Section 3.1.1.1, GS Subsystems, Part e, Simulation Subsystem (SIM). The text describes the Simulation Subsystem as supporting the operation of the Ground Segment and diagnosing processing anomalies. This appears to be a departure from the original Hughes (HAC) concept for the utilization of the Simulation Subsystem. If so, this can impact upon the required "turn-around" time for the simulation operation.

Item: Page 6, Section 3.1.1.2.1, Common CIs. The text states that the System Data Base is used by all subsystems except the Simulation Subsystem. This appears to be contradicted by Fig. 3-2 on Page 10. Aren't previous runs from the simulation stored in the LRS?

Item: Page 8, Section 3.1.2, Mission. The text asserts that the mission of the Ground Segment is to provide the products necessary to prove the concept of LWIR space surveillance with respect to automated data processing (background discrimination, including MTI, pulse and noise suppression and color temp-

* See Ref. 6 in section V of this report.

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erature techniques). The impact of this mission requirement in this specification is to upgrade the objective of the data processing development. That is, it would appear that the algorithms being developed for the SIRE data processing system have taken on the character of being the prototypes for those to be used in the DSSS. Originally SIRE was only to gather the data and develop the techniques which would be then used to develop the optimum algorithms for DSSS.

Item: Page 10, Figure 3-2, SIRE Ground Segment Subsystems. The Simulation Subsystem block shown in the figure has just outputs, no inputs; this seems strange. What appears to be missing are at least the tasking inputs and parameter inputs. As stated above, the Simulation Subsystem block does show flow from the simulation to the LRS.

Item: Page 19, Section 3.1.5.2.2, EPS-DAS. The text states that the Data Analysis Subsystem (DAS) shall provide detailed feedback to the Experimental Planning Subsystem (EPS) on the quality of the SIRE experiment data that has been collected and analyzed. The nature of this detailed feedback is only implied; it is not specified in any real detail.

Item: Page 19, Section 3.1.5.2, Internal Interfaces. It would appear that the internal interface between the LRS and the Simulation Subsystem is not called out although, in Section 3.1.5.3.8 SIM-DAS, it is stated that data from the SIM shall be installed in the LRS prior to actual processing by the DAS. For consistency, it is recommended that this interface between the SIM and the LRS be spelled out in this section.

Item: Page 21, Section 3.1.7.1.1, Timeliness of Ground Segment Operations with Respect to DSSS Development. In this section Ground Segment requirements are tied directly to the DSSS program development. The text states that the data produced from

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the Ground Segment shall be of sufficient quality to allow rough DSSS system sizing and design to proceed. The point here is: While this statement is a replay of what is stated in the mission requirements document, is it appropriate to have it here? Secondly, what is the quality of "rough" and who determines this quality? Furthermore, the last sentence in this section describes the outputs as to include maps. This particular output has not been decided upon by SAMSO.

Item: Page 21, Section 3.1.7.2.1, SAMSO/YNCS (SPO). The last sentence states: "The GS Experiment Director will represent YNCS." Represent should be changed to "be."

Item: Page 23, Figure 3-5, Ground Segment Subsystems-Functional Flow. It is recommended that an arrow be drawn from the SIM box to the LRS box.

Item: Page 24, Section 3.1.7.4.2, Tracking Proof-of-Concept. Text states that target tracks will be formed in "internal" coordinates. It is believed that this is a mistake and that it is meant to say "inertial" coordinates. If it is not a mistake, how would such tracks be compared with ADCOM track data?

Item: Page 24, Section 3.1.7.4.3, Star Mapping. The text clearly states that the objective of this experiment is to create an LWIR star map. Should it not state that it should be the objective to gather the data for an LWIR star map?

Item: Page 24, Section 3.1.7.4.5, Earth Limb/Aurora. The text states that the objective of the Earth Limb experiment is to determine the temporal and spatial modulation. In actuality, the objective of the Earth Limb experiment is to determine whether spatial modulation even exists. Consequently, the wording should say "determine the extent of temporal and spatial modulation."

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Item: Page 24, Section 3.1.7.4.6, Zodical Radiance. In this section the text discusses the measurement of spatial modulation. Again, as in the above statement, the existence of spatial modulation is to be determined by this experiment. Consequently, the wording should state that the experiment is "to determine the extent of spatial modulation."

Item: Page 27, Section 3.2, Ground Segment Performance. In the following subsections numerical values are given for the various performance requirements. It is recommended that the values be referenced explicitly to the mission requirements document, where applicable.

Item: Page 27, Section 3.2, Ground Segment Performance. Where is the error budget for the GS specifications derived? Are trade-offs available?

Item: Page 30, Section 3.2.3.6, Pointing Accuracy. The error bands for the coverage determination programs are ill-defined. Is the ± 0.05 degree value for all target altitudes?

Item: Page 33, Section 3.2.7, Data Analysis. What is the response time requirement for the Data Analysis Subsystem; it is not specified in Section 3.2, Ground Segment Performance?

Item: Page 36, Section 3.2.7.6.4, Star Map Processing. Why doesn't Star Map position error contribution (0.16D) equal LOS position measurement error contribution (0.08D) on page 34, Section 3.2.7.4?

Item: Page 36, Section 3.2.7.6.8, Selected Target Data Processing. What processing may be required for Space Object Identification?

Item: Page 37, Section 3.2.7.6.9, Tracking Proof-of-Concept Processing. What is the probability of mistaking an RSO for a star? Is this probability included in the calculation of the probability of false alarms?

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Item: Page 42, Section 3.2.10, SIRE System Simulator Functions.
Will the simulation be "validated" during operations? Is this an output of Data Analysis?

Item: Page 42, Section 3.2.10 SIRE Simulation Simulator Functions.
No where in the text is the interface between the Simulation System and the Data Analysis System described in any real detail. Again, the question of feedback to the Experiment Planning Subsystem is not described.

Item: Page 58, Section 3.5.3, Facilities. The text states that the Ground Segment shall be capable of processing, storing and disseminating classified information up to the top secret level. Should it not state; up to and including the top secret level? Overtly or inadvertently, operational U.S. space systems will be observed by SIRE. The classification of this data may exceed the secret level.

Item: Page 60, Section 3.7.1, Experiment Planning Subsystem (EPS). The text states that the EPS controls all information exchange across external interfaces with other agencies. This statement may contradict what is shown in Fig. 3-2 on page 10. Does the term "other agencies" include all SIRE taskers and users?

Item: Page 62, Table 3.7.1, Allocation of Performance Requirements to EPS Configuration Items. The Performance Characteristics Referenced Paragraphs numbers do not "appear" to correspond to the text referenced.

Item: Page 65, Section 3.7.1.3.1.4, Tasking Control. The text states that retasking requests are accepted from the Quality Evaluation Subsystem. Does this subsystem actually initiate re-tasking request or furnish data to decide on retasking requests?

Item: Page 65, Section 3.7.1.3.1.6, Tasking Status. The text discusses how the interface procedure maintains an account of

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tasks entered into this system, tasks satisfactorily completed and tasks to be accomplished. Does it keep records of resources expended for past tasks? This might be required to assign proper allocation of costs, charges, etc. to individual users.

Item: Page 69, Section 3.7.1.4, Zodical Radiance/Earth Limb Coverage Determination CPCI. Is this Coverage Determination CPCI different from the other Coverage Determination CPCIs? If so, in what way?

Item: Page 71, Section 3.7.1.4.7, ZR/EL Data Outputs, Item K. The text calls for "run statistics." What are they?

Item: Page 72, Section 3.7.1.5.2, Target CPCI Inputs, Item A. The text states that the target CPCI uses inputs of the viewing aspect angle to the target. Is this aspect angle to the vehicle or to the vehicle's trajectory? This question has impact on the sophistication of the trajectory prediction algorithms to be used by SIRE.

Item: Page 84, Section 3.7.2.11.8, Data Quality Enhancement. The text states that a capability shall be provided for the operator to access and modify selected processing variables. The text does not describe in any detail as what the processing variables are or the extent of the modification. This section needs clarification.

Item: Page 86, Section 3.7.2.12.2, Detector Data Merging. The text states that the verification of a source may be accomplished by checking the sensor response in multiple bands. This is a necessary but not sufficient criteria. Under some circumstances valid responses can be found in some bands but not others.

Item: Page 87, Section 3.7.2.12.5.1, Experiment Data Quality, Item C. It is recommended that the text reads as follows: Verification shall be provided of the extent of any structure and intensity levels of the earth limb, etc.

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Item: Page 87, Section 3.7.2.12.6, Color Graphic Displays, Item A1. It is recommended that the text reads as follows: Displays of diffuse sources shall present the extent of any structural, etc.

Item: Page 95, Section 3.7.3.3.1, Earth Limb Radiance Catalog. The term longitude should follow latitude in the third sentence.

Item: Page 125, Section 3.7.5.5, SIM Database CI. This section describes how the Simulation Subsystem provides and maintains a database equivalent to the Ground Segment operational database. The data contained in this database are the physical, mathematical and system constants used in the SIRE system. This information is also contained in the Ground Segment database. There is an obvious operational link between the two databases. Why are the two separate?

Item: Page 130, Section 6.1, Items Provided by Data Processing Associate Contractor. The text states that the stated items are to be provided by the SIRE Data Processing Associate Contractor for use by the SIRE program at no expense to the SIRE program. Does this mean that the items listed in this section are to be Contractor Furnished?

Item: Page 131, Section 6.1, Items Provided by Data Processing Associate Contractor, Item 11. Is the list of the color graphic display capabilities all inclusive, or are they the minimum set?

C. COMMENTS ON THE HUGHES SIRE GROUND SEGMENT CONCEPT AND SYSTEM DESCRIPTION DOCUMENT

This appendix presents the detailed comments resulting from RRI's review of the HAC "SIRE Ground Segment Concept and System Description*" document; item numbers (page, section, figure, etc.) refer to numbering in that document.

* See Ref. 7 in section V of this report.

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Item: Page 1, Section 1.3, Ground Segment Mission. According to Hughes Aircraft Company (HAC) the mission of the Ground Segment (GS) is to provide the products necessary to prove the concept of LWIR Space Surveillance with respect to automated data processing (background discrimination, including MTI, color temperature, pulse and noise suppression techniques). It would appear that HAC has upgraded the development of the automated data processing in SIRE to a Proof-of-Concept. Originally, SIRE was conceived as being an experiment to obtain the data from which the optimum algorithms for DSSS would be developed. It now appears that SIRE, according to HAC, will develop the optimum algorithms within the program itself.

Item: Page 2, Section 1.4, Program Management Overview, Third Paragraph. The text reads in the second sentence: "The STSI will integrate and test hardware, software and interfaces at the system level." The question is, should system be replaced by the term segment? The reason for this question is because HAC has divided SIRE's organization into three levels. The first and highest priority level is system; the next is segment and then subsystem. The SIRE Data Processing contractor is considered responsible for the subsystem specifications. Consequently, HAC should be considered responsible for the segment level specifications.

Item: Page 2, Section 1.4, Program Management Overview, Last Paragraph. HAC describes NASA as the SIRE Data Processing Associate Contractor. This is the first time that the term Associate Contractor for the Data Processing Contractor has been used. Does this connotation have some legal meaning?

Item: Page 6, Section 2.2.1, Items External to the Ground Segment Part E. The text describes the following: "SIRE Ground Segment operations will be under the management control of YNCS."

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The STSI will be responsible for implementing the management directives of SAMSO/YNCS." This structure would indicate that the management control of SIRE goes from SAMSO through the STSI to the data processing contractor, namely, NASA.

Item: Page 6, Section 2.2.2, Ground Segment, Part A. HAC describes the Experiment Planning Subsystem (EPS) as scheduling and controlling the processing functions. This, in essence, assumes that HAC is in control of the operations, not NASA.

Item: Page 8, Section 2.2.2, Ground Segment, Part B. In the description of the Quality Evaluation Subsystem (QES), it is clear that all the functions of what was originally known as the Data Reduction Subsystem have now been subsumed into the QES. There no longer is a subsystem designated as Data Reduction.

Item: Page 8, Section 2.2.2, Ground Segment, Part E. In the description of the Simulation Subsystem (SIM), the capability for diagnosing processing anomalies has been provided. It appears that HAC has had a change of thinking with regards to using the simulation subsystem for diagnostics. This may now impose a more rapid processing operational capability upon the system.

Item: Page 10, Figure 2-3, SIRE Ground Segment Organization. It appears from the figure shown that NASA will not be involved in any Data Analysis.

Item: Page 18 to 22, Section 3.4.1.1.1, Experiment Tasking Interface. The text describes the Experiment Planning Subsystem (EPS) as managing all ground segment interfaces with external agencies. External tasking requests are accepted from the SIRE project office. Consequently, all external requests will be coming through SAMSO, and not through the STSI directly.

Item: Page 22, Paragraph on Planning Board. It is clear from the text that SAMSO, described within as Experiment Director,

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will be expected to meet everyday with other members of the EPS to review the previous days operations, the experiment plan for the day, and the disposition of special tasking and resources.

Item: Page 23, Section 3.4.1.1.2, Experiment Coverage Determination, Fourth Sentence from the Bottom of the First Paragraph. The term South American anomaly should be South Atlantic anomaly.

Item: Page 28, Section 3.4.1.2, Quality Evaluation. This description reaffirms an earlier conclusion that the Quality Evaluation Subsystem now includes what was formally regarded as the data reduction section.

Item: Page 29, Section 3.4.1.2.2, Initial Data Reduction Element. This section discusses the display capabilities to be provided by the color graphic device. The emphasis here, surprisingly, is on "display." There is no discussion about the need for possible threshold control, algorithm manipulation, etc. for use in an interactive manner by the operator. Also, there is no discussion about the need for processing or displaying hardware data on these devices. In fact, some of these display capabilities may be producible on ordinary black and white displays rather than color. No information is given, nor referenced, regarding the required quality nor accuracy of the display.

Item: Page 30, Section 3.4.1.3, Data Analysis Subsystem. The description given here is quite poor, being only general in content. Again no information is given, nor referenced, regarding the quality or accuracy standards to which the system must work. In paragraph 2 of this section, it is stated that the Data Analysis Subsystem will provide analysis feedback data to the Experiment Planning Subsystem for collection retasking purposes. However, exactly what will be provided in the feedback is not specified.

Item: Page 31, Sections 3.4.1.3.1 through 3.4.1.3.7. These sections give a description of each of the elements composing

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the Data Analysis Subsystem. Again, no accuracy requirements are given nor referenced.

Item: Page 32, Section 3.4.1.4, Library and Reporting. In this section, the text discusses how the library function will furnish reports to the various external tasking agencies. It is recommended by RRI that costs for processing these external requests should be determined by the system. Consequently, the system should allow for this accounting function.

Item: Page 33, Figure 3-5, Library and Reporting System Interfaces. In the figure, reports are shown flowing from the LRS through a manual interface into the Contracting Agency. This figure does not agree with Figure 3-8. First, the manual interface is not designated as in Figure 3-5; in Figure 3-8, the manual interface is shown as the STSI. Secondly, in Figure 3-8 the YNCS is also shown as being in the loop from the LRS to the Contracting Agency.

Item: Page 40, Figure 3-8, Report Source and Destination. The figure indicates that all contacts between the STSI and a contracting agency, regarding distribution of reports, is through the YNCS group at SAMSO.

Item: Pages 43 and 44, Section 3.4.1.5, Simulation. Again the text implies that the simulation will perform anomaly diagnosis or diagnostic functions. Since algorithm evaluation is called out as a separate capability, the diagnostic function might be construed as being performed during the operations portion of the SIRE program. If so, this is a departure by HAC from the original simulation concept.

Item: Page 59, Section 4, Experiments. In the description of the experiments, the text does not present measurement requirements nor does it reference any.

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Item: Page 69, Figure 4-2, QES Processing Flow (Common Processing). In the figure, a Data Evaluator is shown performing a preliminary look on the pre-processed data from the Signal Processor. It is not indicated whether this Data Evaluator has the ability to stop the processing should there be any problems with the data at this point. Secondly, is there a functional block between RCV Data from Signal Processor and the Data Evaluator to interface with the display software?

Item: Page 71, Figure 4-4, DAS/LRS Processing Flow. It appears in the figure that the data has to be processed through the DAS in order to evaluate target tracks.

Item: Page 73, Section 4.2.1.3.1, Coverage Determination. The text states that a SIRE orbit prediction of 2-3 weeks is utilized to determine the future time intervals for satellite viewing. The question here is: Who performs this orbit prediction and are these numbers of 2-3 weeks prediction compatible with ADCOM accuracies?

Item: Page 81, Section 4.2.3.3, ELR Quality Evaluation. In the third sentence, longitude should follow latitude.

Item: Page 90, Section 4.2.7.5, Target Quality Evaluation. It is difficult from the text to understand what quality factor is exactly being determined.

Item: Page 97, Section 5, Ground Segment Operations Manning. Nowhere in the text is answered the question as to how security will be maintained with regards to the sensitivity of the target data. The problem occurred on the CMP effort when RSOs were inadvertently collected along with star backgrounds and other point sources in the celestial sphere. A security issue was then raised some years later on whether or not these targets were excised from the star data and if not, were they identified in order to properly classify the data.

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GLOSSARY

ADCOM - U. S. Air Force Air Defense Command
CI - Configuration Item
CMP - Celestial Mapping Program
CPCI - Computer Program Configuration Item
DAS - Data Analysis Subsystem
DSSS - Deep Space Surveillance Satellite
EL - Earth Limb
EPS - Experiment Planning Subsystem
GS - Ground Segment
HAC - Hughes Aircraft Company
LOS - Line of Sight
LRS - Library and Reporting Subsystem
LWIR - Long Wave Infrared
MTI - Moving Target Indicator
NASA - National Aeronautics and Space Administration
QES - Quality Evaluation Subsystem
RRI - Riverside Research Institute
RSO - Resident Space Object
SAMSO - U. S. Air Force Space and Missile Systems Organization
SIM - Simulation Subsystem
SIRE - Satellite Infrared
SPO - System Project Office
ZR - Zodiacal Radiance